environments, especially since many of these sites were in relatively pristine locations. The higher percentage of creek habitat with fair or poor conditions may also reflect, in part, the relatively greater effect of anthropogenic runoff into these smaller water bodies due to their proximity to upland sources and their lower dilution capacity.

Comparison of the state's overall water quality condition on an annual basis indicated very little change over the six years sampled by SCECAP to date (Figure 3.2.7). This is surprising since the state's estuarine habitat was altered considerably by increased rainfall in 2003 and 2004 based on the changes in the proportion of the state represented by the various salinity zones (Figure 3.2.1). For all years, about 80% or more of the state's estuarine waters rank as good in quality using the SCECAP criteria, and generally less than 5% of the estuarine waters ranked as poor in quality. We anticipated that the increased rainfall experienced during 2003-2004 might have an impact on the state's overall estuarine water quality, but the resulting data did not confirm this. Although some of the component parameters did show evidence of considerable change, the actual concentrations observed among the various sites sampled in a given year, combined with the mitigating effects of those parameters that did not show much change, are the probable reasons for a lack in major changes in the integrated water quality index.

3.3 Sediment Quality

Sediment Composition

The composition of marine sediments can affect the structure of benthic communities, the exchange rates of gases and nutrients between the water column and seafloor, and the bioavailability of nutrients and contaminants to resident fauna (Gray, 1974; Graf, 1992). In general, muddier sediments (those with more silt and clay) tend to host a different set of species, reduce the movement of gasses and nutrients, and retain more contaminants than sandier sediments.

During the 2003-2004 monitoring period, sediments in open water habitats were on average 19.6% silt/clay while sediments in tidal creek habitats were 30.4% silt/clay, a difference that was significant ($p = 0.013$). Within each habitat type, the percent silt/clay was highly variable, with open water stations varying from 0.7-94.7% and tidal creek stations varying from 2.0-97.8%. The sediments at one open water station (2.0%) and four tidal creek stations (7.0%) had greater than 80% silt/clay (Figure 3.3.1). These values are similar to previous study periods (Van Dolah *et al.,* 2002a, 2004a).

Sediment Total Organic Carbon

Total organic carbon (TOC) represents a measure of the amount of organic material present in sediments. At very low TOC levels, little food is available for consumers resulting in a low biomass community; at very high TOC levels, enhanced sediment respiration rates lead to oxygen depletion and accumulation of potentially toxic reduced chemicals. Hyland *et al*. (2000) found that TOC levels below 0.5 mg/g (0.05%) and above 30 mg/g (3.0%) were related to decreased benthic abundance and biomass.

The TOC content of open water sediments averaged 0.8% while tidal creek habitats averaged 1.2%, a difference that was significant ($p = 0.048$). The TOC of open water habitats varied from 0.03% to 5.5% and that of tidal creeks varied from 0.05% to 5.5%. Based on the criteria in Hyland *et al.* (2000), the sediments were impaired with respect to TOC at 20% of open water habitats (14% too low, 6% too high) and 15% of tidal creek habitats (3% too low, 12% too high; Figure 3.3.1). These values are similar to previous surveys (Van Dolah *et al.,* 2002a, 2004a). The tendency of open water habitats to be characterized by lower TOC levels than tidal creek habitats likely reflects their greater distance from terrestrial sources of organic material.

Porewater Ammonia

Total ammonious nitrogen (TAN) provides a measure of the concentration of ammonia, a highly reduced and potentially toxic form of nitrogen, in marine sediments. Sources of ammonia include terrestrial runoff, atmospheric deposition and bacterial activity (nitrate reduction and ammonification), many of which are increasingly impacted by human activities, resulting in greater nitrogen loads in coastal environments (Driscoll *et al.,* 2003).

The median porewater ammonia concentration was 1.9 mg/L in open water habitats and 2.1 mg/L

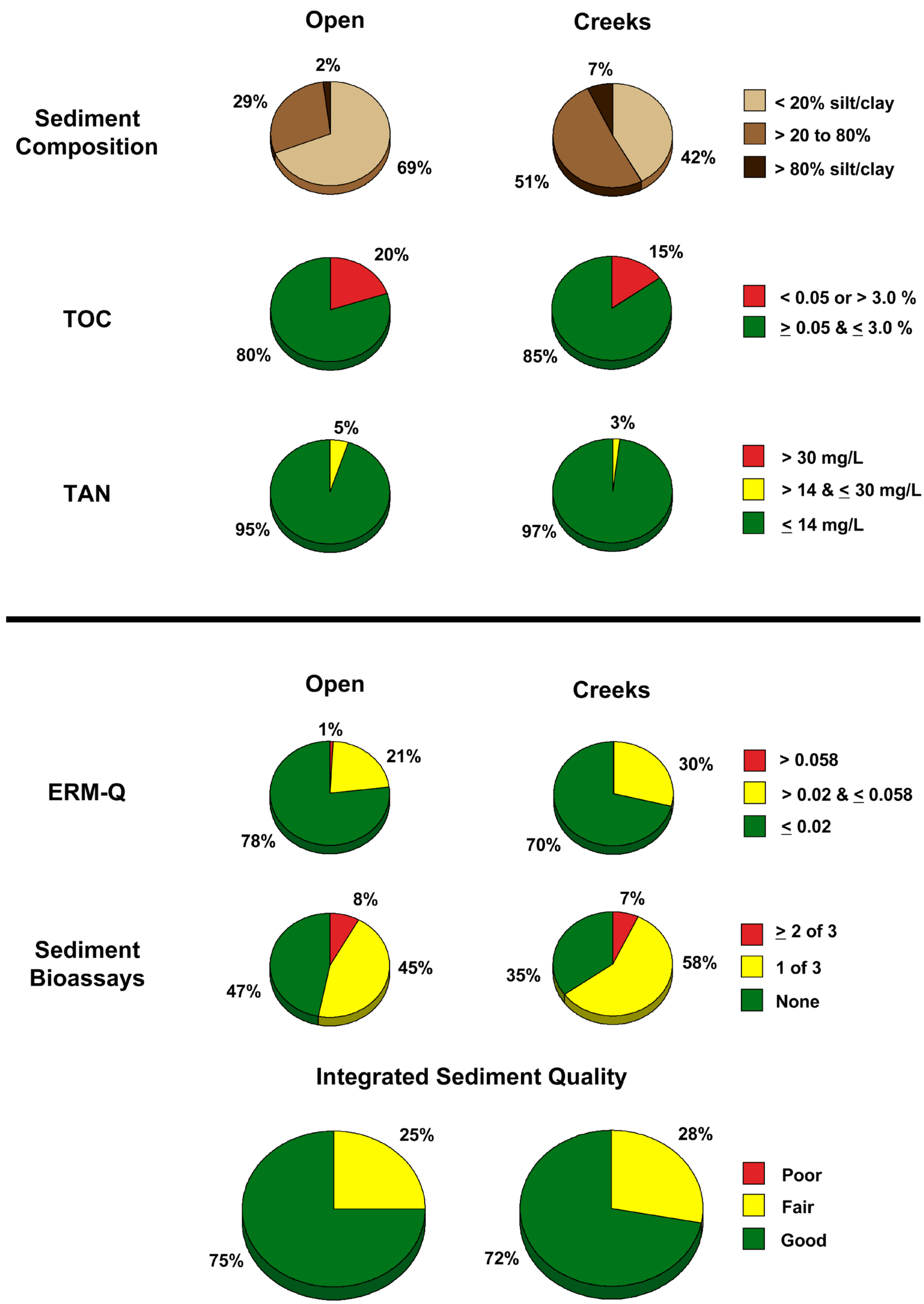
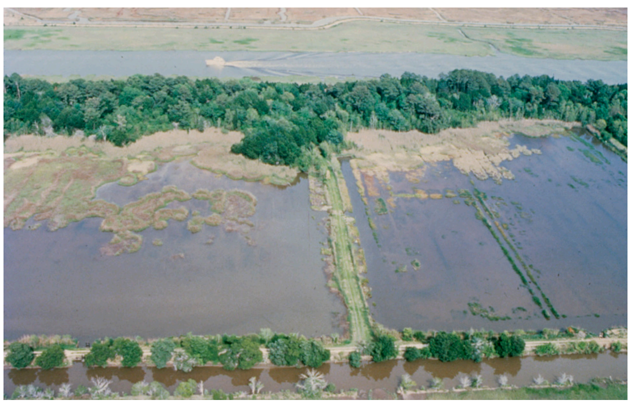


Figure 3.3.1. Comparison of the percent of the state's coastal habitat represented by various sediment quality conditions and integrated sediment quality scores.

in tidal creek habitats, a difference that was not significant. The TAN of open water habitats varied from 0.15 to 30.5 mg/L and that of tidal creeks varied from 0.1 to 25.3 mg/L. On average, less than half of one percent of South Carolina's open water or tidal creek habitat possessed ammonia concentrations characteristics of high stress habitats (Figure 3.3.1). A single station in open water had a TAN concentration of 30.5 mg/L but all remaining open water stations had TAN concentrations of less than 16 mg/L. The unusually high TAN concentration was found at station RO046076 near the confluence of Six Mile Creek and the Santee River. The area surrounding this station consists of extensive impoundments for waterfowl that may act as sources of nitrogen when water is released into the estuary during the late spring and summer.



The Santee River delta is highly impounded to attract waterfowl.

Contaminants

Contaminants enter coastal water bodies through direct release by users, runoff from terrestrial systems, and deposition from suspended material in the atmosphere. Common environmental contaminants include polycyclic aromatic hydrocarbons (PAHs; including compounds such as automobile oil), heavy metals (including mercury, chromium, etc), polychlorinated biphenyls (PCB's; including components of many flame retardants and electrical insulators manufactured before 1979) and pesticides (including DDT, etc.). Although SCECAP determined the levels of 160 contaminants in South Carolina's coastal waters, the consequences of many of these compounds to ecosystem function and human health remain uncertain.

Long and Morgan (1990) and Long *et al.* (1995, 1997) reviewed published toxicological studies involving 24 contaminants (all measured by SCECAP) and developed two metrics: Effects Range-Low (ER-L; concentration of a contaminant that resulted in adverse bioeffects in 10% of published studies) and Effects Range-Median (ER-M; concentration of a contaminant that resulted in adverse bioeffects in 50% of published studies). During the 2003-2004 monitoring period, 33 stations (including 12 open water and 21 tidal creek stations) had at least one contaminant that exceeded its published ER-L, and no station had a contaminant that exceeded its published ER-M. Four PAH's, the pesticide DDT, and 5 metals exceeded published ER-L (Table 3.3.1). The most widespread contaminant that exceeded its ER-L was arsenic. Arsenic accumulates in estuarine sediments as a result of the weathering of terrestrial rock, thus its presence in South Carolina's coastal sediments (particularly in tidal creeks) is likely a result of natural upland erosion. Disturbance of these sediments, such as may occur through slumping, erosion or dredging, however, can re-suspend buried arsenic (Saulnier and Mucci, 2000) making it available for uptake by estuarine fauna and increasing chances of contact with the human population.

To assess the overall bioeffect of the 24 contaminants with published guidelines, an Effects Range Median Quotient (ERM-Q) was calculated for each station. ERM-Q is calculated by dividing the measured concentration of each of the 24 contaminants by its ER-M values and then averaging the 24 values. Hyland *et al.* (1999) demonstrated that ERM-Q provides a reliable index of benthic stress in southeastern estuaries, with ERM-Q values ≤ 0.020 representing a low risk, values > 0.020 and ≤ 0.058 representing a moderate risk, and values > 0.058 representing a high risk of observing degraded benthic communities. The median ERM-Q of open water sediments was 0.010 and that of tidal creeks was 0.014, a difference that was not significant. ERM-Q varied from 0.001 to 0.076 in open water habitats and from 0.003 to 0.056 in tidal creek habitats. ERM-Q values were in the moderate risk range in 30% of the state's tidal creek habitat and 21% of the state's open water habitat and in the high risk range in 1% of the state's open water habitat (Figure 3.3.1). One open